Optoelectronics in 1D and 2D materials

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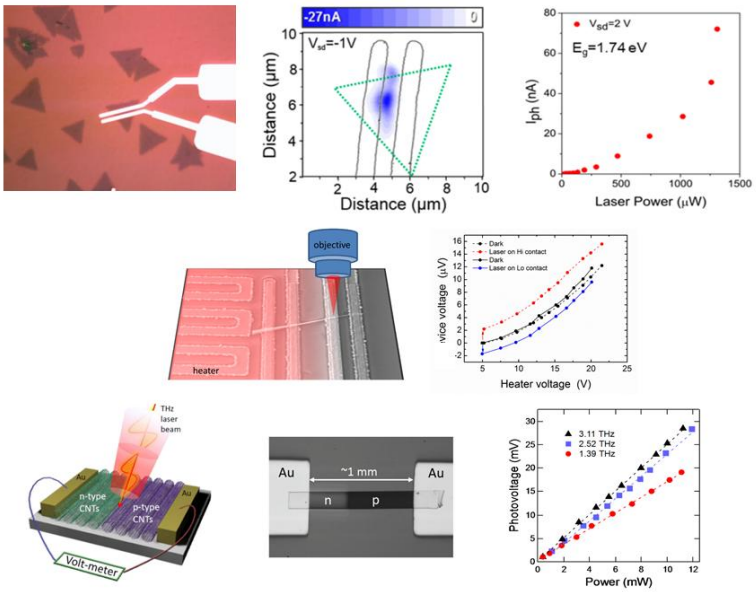
Low-dimensional materials such as graphene, transition metal dichalcogenides, semiconducting nanowires, and carbon nanotubes, have attracted attention for applications in electronics and photonics, as well as for the wealth of new scientific phenomena that arise at reduced dimensionality. In this presentation I will discuss our experimental and theoretical work to develop a fundamental understanding of optoelectronic phenomena in such systems, and to exploit these nanomaterials for photodetection applications. For example, we use spatially-resolved photocurrent measurements combined with other techniques (e.g. thermoelectric measurements, Raman thermography) to identify the origin of the photocurrent in nanowires and 2D materials. We reveal a new regime of operation in MoS_2, $MoSe_2$, and their alloys, where the photocurrent depends superlinearly on light intensity(*1*). In the case of GaN/AlGaN nanowires, we combine optoelectronic and thermoelectric measurements to reveal the coexistence of photogating and photothermoelectric effects(*2*). Finally, I will discuss the realization of broadband infrared and terahertz photodetectors using macroscopically aligned carbon nanotubes(*3-6*).



1. V. Klee *et al.*, Superlinear Composition-Dependent Photocurrent in CVD-Grown Monolayer $MoS_{2(1-x)}Se_{2x}$ Alloy Devices. *Nano Lett.* **15**, 2612-2619 (2015).
2. F. Léonard *et al.*, Simultaneous Thermoelectric and Optoelectronic Characterization of Individual Nanowires. *Nano Lett.* **15**, 8129-8135 (2015).
3. X. He *et al.*, Carbon Nanotube Terahertz Detector. *Nano Lett.* **14**, 3953-3958 (2014).
4. X. He *et al.*, Photothermoelectric p–n Junction Photodetector with Intrinsic Broadband Polarimetry Based on Macroscopic Carbon Nanotube Films. *ACS Nano* **7**, 7271-7277 (2013).
5. S. Nanot *et al.*, Broadband, Polarization-Sensitive Photodetector Based on Optically-Thick Films of Macroscopically Long, Dense, and Aligned Carbon Nanotubes. *Sci. Rep.* **3**, 1335 (2013).
6. K. J. Erikson *et al.*, Figure of Merit for Carbon Nanotube Photothermoelectric Detectors. *ACS Nano* **9**, 11618-11627 (2015).